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# SOME IMPORTANT ANIMAL PARASITES AFFECTING OHIO LIVE STOCK

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## INTRODUCTION

Parasites that infest farm animals cause enormous losses to the livestock interests of Ohio. The exact, or even approximate, extent of these losses is not known and probably never will be determined. However, sufficient information is at hand to show that the damage done by the more common parasites, external and internal, is of great economic consequence as well as of much scientific interest.

While the study of this subject at this Station has only begun, it has already shown that the field is an important one, and it is believed that Ohio stockmen will be interested in acquainting themselves with some facts concerning the more common and important parasites that infest Ohio livestock. All who know of the existence of parasites in their flocks and herds are requested to send specimens and complete information concerning them to the Experiment Station, to aid in this study.

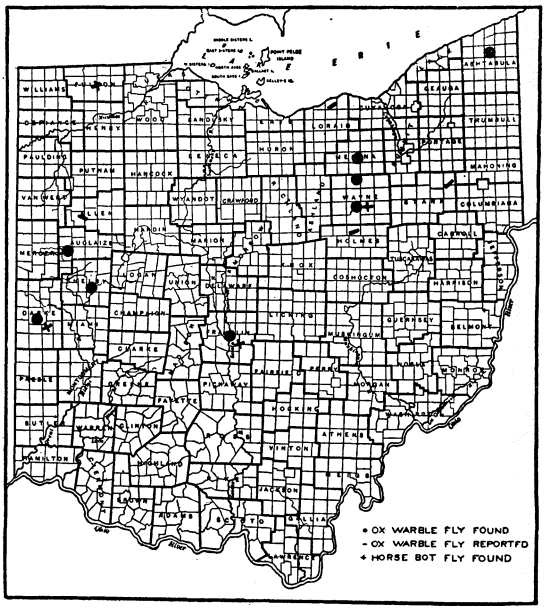
This publication is not issued as an exhaustive treatise, but rather, as an introduction to the subject, calling attention to some of the parasites that are prevalent in the state and suggesting some measures to be taken in combating them.

## DESIRABILITY OF A KNOWLEDGE OF DISTRIBUTION

The importance of a knowledge of the distribution of an animal parasite throughout the state is not generally appreciated. A review of the history of the hook worm in man, of sheep scab, and of Texas fever in cattle—three of the most widely known diseases due to animal parasites, will indicate how absolutely essential are

the records of distribution. The records revealed the economic importance of these diseases. They showed that they were not merely of local or limited interest, but of general importance. When facts regarding their distribution were known, quarantines were established in the cases of sheep scab and Texas fever, and every effort was made to stamp out these diseases in the infected areas and to prevent their spread.

In the case of the hook worm disease, the preliminary records of Stiles made it possible for various physicians intelligently to add to the records, thus mapping the infected areas. Physicians in the states from which it was recorded or where observations indicated that it might be found were thus induced to look for it. When all these records were tabulated they indicated how much significance should be attached to the hook worm disease, and the states in which a campaign of extermination should be undertaken.




A knowledge of a parasite's distribution may possibly throw some light upon its habits and life history. Such a knowledge may indicate whether the conditions necessary for its development exist only in a restricted area or over the entire state. The corresponding distribution of an intermediate host may be brought to light. All this knowledge would in turn be useful in outlining more nearly adequate means of controlling the parasite.

The distribution maps indicate that but little is really known concerning the distribution of even the most common and destructive parasites. There are several reasons for this state of affairs. As a rule farmers do not make careful post-mortem examinations of their animals, and on this account are often not aware that they are infested. Moreover, when a parasite is found it is fre-

quently looked upon as a curious object that is of little importance. If the parasite is common in the neighborhood it is often passed by with but little mention. The real value of recording such observations cannot be too strongly emphasized. Professor Herbert Osborn ('12)* in writing of this part of scientific investigations, says:

"While the preparation of such lists may by some be considered as a rather easy part of entomological investigations, it appears to me that, accurately done, work of this kind becomes of the highest scientific value, and that we may very well encourage it to the greatest extent possible.

"In many cases isolated individuals are deterred from undertaking the listing of their native species because of the idea that such work is not of primary importance, or from the difficulties encountered in finding the most satisfactory methods of preparation for various groups, or securing the identification of such groups as may be outside their own field."

Though the above was written concerning entomological investigations, it applies equally well to parasitological investigations, for in this field there are but few amateur collectors and contributors of short notes and records.

## PRELIMINARY LIST OF PARASITES FOUND INFESTING OHIO LIVE STOCK

The following list contains the species of internal and external parasites which have been collected by or for the writer in Ohio. It is recognized that this list is very incomplete, but it is given with the hope that it will serve as a nucleus around which new records may be grouped. The organ in which each species is most commonly found, together with the locality in which it was collected, is mentioned. These localities, it should be stated, are not the only ones in which the parasites may be found, but are only the ones in which the parasites have been collected. The abbreviation "Coll." stands for "collector," and "Det." for "determined by".

Horse, parasites of the:

I. Nemathelmintha,

a. Nematoda, round worms.

*Ascaris equorum*:—Small intestine. Wayne, Franklin and Meigs counties. This is the largest round worm found in the intestines of the horse. It measures from 6 to 15 inches in length and from 1/5 to 1/4 inch in width. Its body is yellowish white.

*The full titles of publications to which reference is made will be found at the end of this bulletin, in the section headed "Bibliography," page 52. The references are there arranged in alphabetical order according to authors. Where more than one paper by the same author is mentioned, these are arranged chronologically by date of publication.

II. Arthropoda,
a. Insecta.
(1.) Diptera.

*Gastrophilus intestinalis* (Horse bot larva):—Stomach. Wayne county. Coll. McLaughlin, Franklin county. See p. 31.

*Gastrophilus intestinalis,* (Horse bot fly):—Adult fly; Meigs and Darke counties. Coll. and Det. Hine, Fulton county. See p. 31.

(2.) Mallophaga.

*Trichodectes parumpilosus*:—Skin. Wayne county.
This parasite is the biting or scale-eating louse of horses. It frequently becomes numerous enough during the latter part of the winter to cause great irritation.

Cattle, parasites of:

I. Arthropoda.
a. Insecta.
(1.) Diptera.

*Hypoderma lineata,* (Cattle grubs—Ox warble fly):—Subcutaneous; Wayne, Medina, Ashtabula, Franklin, Darke, Shelby and Auglaize counties. See p. 33.

(2.) Mallophaga.

*Trichodectes scalaris*:—Skin. Wayne county.
This is the biting louse of cattle. When in sufficient numbers it causes considerable irritation and annoyance, but is not as injurious as the blood sucking louse.

(3.) Hemiptera.

*Haematopinus eurysternus*:—Skin. Coll. Revert, Seneca county; McGugin, Lawrence county.
This parasite is the short-nosed, blood sucking louse of cattle.

Sheep, parasites of:

I. Platyhelmintha, flat worms.
a. Cestoda, tape worms.

*Moniezia planissima*:—Small intestine. Meigs county. Det. Foster.
This tape worm is doing considerable damage to sheep, more especially lambs, of Meigs county. The adult worms measure two feet or more in length. They are of a yellowish color, and the ripe segments

are quite thin and much broader than long. Its life history is unknown.

II. Nemathelmintha,

a. Nematoda, round worms.

*Bunostomum trigonocephalum*:— Small intestine. Meigs and Wayne counties. Det. Ransom.

This worm, the hook worm of sheep, is a blood sucker and is no doubt quite injurious when present in large numbers. It is usually found in the fore part of the small intestine attached to the intestinal wall. It measures from ½ inch to 1 inch in length and from 1-50 to 3-100 inch in thickness, and is of a reddish brown color when full of blood. Its life history may possibly be similar to that of the hook worm of man, i. e., direct without an intermediate host.

*Haemonchus contortus,* (Sheep stomach worm) :—Fourth stomach. Meigs and Wayne counties. See p. 38.

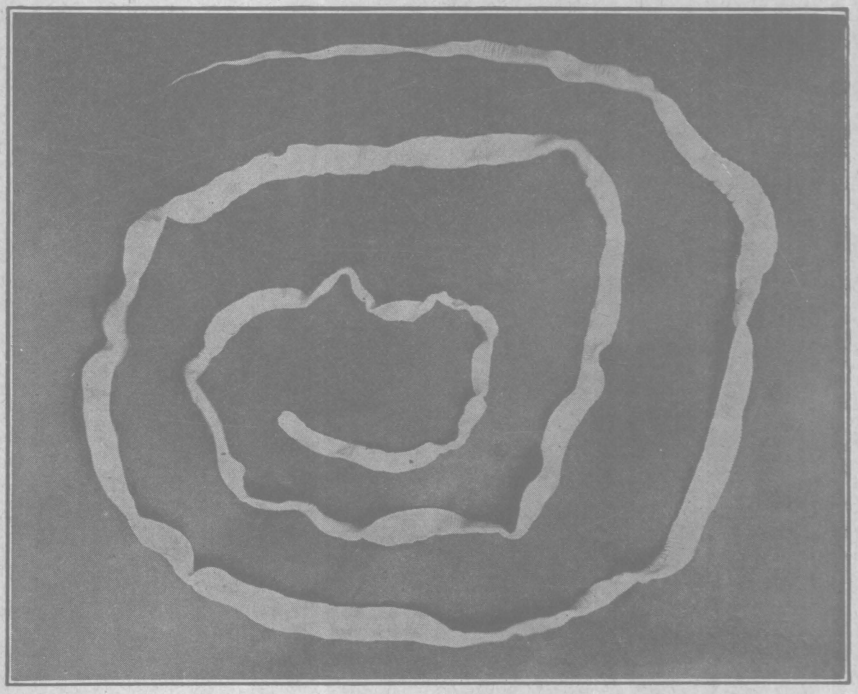


**Fig. 1. A sheep tape worm (*Moniezia planissima*) about one-third natural size.**

*Nematodirus filicollis*:—Small intestine. Wayne county. This is a very slender, hair-like, whitish or reddish worm, measuring from 2/5 to 4/5 inch in length. It does not appear to be as common as *Bunostomum trigonocephalum*.

*Oesophagostomum columbianum*, (Nodular worm):—Large intestine. Meigs county. Det. Ransom. See p. 39.

*Trichuris ovis*:—Caecum. Meigs and Wayne counties. This worm is sometimes called the whip worm because of its long, thread-like, anterior portion and thicker, short, posterior portion. The slender anterior portion of the body equals two-thirds to three-fourths of the total length of the worm. It measures from two to three inches in length. It is usually found attached very firmly to the mucous lining of the caecum.

III. Arthropoda.

a. Insecta.

(1.) Diptera. Two-winged flies.

*Oestrus ovis*:—Nasal passages and frontal sinuses. Meigs county.

This parasite is the larva of the sheep bot or nostril-fly. The malady it causes is sometimes called "grub in the head." The grubs may be found in the nostrils and nasal cavities. It is very common in some, perhaps all, parts of the state.

*Melophagus ovinus*:—Skin. Wayne, Medina, Franklin and Ashtabula counties.

This parasite is the so-called sheep tick. It is not, however, a true tick. It has only six legs, while a true tick has eight. Its life history is peculiar in that the larvae develop and pupate within the body of the female. On being deposited, the covering of the puparium is soft and pale. Soon, however, this covering becomes hard and dark brown in color.

Hogs, parasites of:

I. Nemathelmintha,

a. Nematoda, round worms.

*Ascaris suum*:—Small intestine. Wayne and Miami counties. See p. 43.

*Arduena strongylina*:—Stomach. Wayne county. Det. Foster.

This worm attains a length of 2/5 to 4/5 inch and a width of about 2-125 inch. Seven of the 31 hogs postmortemed by the writer during the summer and fall of 1912 were infested with this worm.

*Metastrongylus apri,* (Lung worm):—Trachea and bronchi. Wayne and Miami counties. Det. Foster. See p. 42.

*Oesophagostomum dentatum*:—Large intestine. Wayne county. Det. Foster.

The body of this worm is white or grayish brown, straight and narrrowed at each end. The adults, measuring from 2/5 to 3/5 inch in length, live in the large intestine. The larvae are found encysted in the wall of the large and small intestines, forming nodules. This worm was found in only two animals during 1912.

b. Acanthocephala.

*Giganthorhynchus hirudinaceus,* (Thorn-headed worm): Small intestine. Coll. Wood, Union county. See p. 45.

II. Arthropoda,

a. Insecta.

(1.) Hemiptera.

*Haematopinus suis*:—Skin. Wayne county.

This insect is the common louse of hogs. It is a blood sucking louse and is capable of doing much injury to swine when present in large numbers.

Chicken, parasites of the:

I. Platyhelmintha, flat worms.

a. Cestoda, tape worms.

*Davainea tetragona*:—Intestine. Coll. Hurst, Pickaway county. Det. Foster.

This tape worm measures from 2/5 inch to 10 inches in length by 1-25 to 4-25 inch in width. The head is about the size of a pin point and is provided with suckers, by means of which it attaches itself to the intestinal wall. The head is joined by a long, slender neck to the rest of the body, which is divided into segments. Some distance from the neck mature segments may be found; that is, segments that are provided with mature male and female sexual organs. Each segment is hermaphrodite. Near the end of the worm, segments that are ripe and filled with eggs

may be found. These ripe segments become detached and pass out to the ground with the droppings. Its complete life history is unknown.

*Davainea cesticillus*:—Intestine. Pickaway county. Det. Foster.

This tape worm is, to the unaided eye, somewhat similar to the one above. It is not so long, measuring from 2/5 inch to 4 inches in length, but is about as broad. To distinguish the tapeworms from each other would require a close microscopic study. This worm and *Davainea tetragona* were found associated with a fatal disease of chickens in Pickaway county. That they were the cause of the disease could not be definitely established, owing to the fact that the disease had abated before the writer could make any post-mortem examinations. The birds that died may possibly have been heavily infested with these worms.

*Hymenolepis carioca*:—Intestine. Wayne county. Det. Foster.

This tape worm is readily distinguished from the others on account of its slender and almost thread-like form. It is very delicate and for this reason complete specimens are difficult to obtain, the head being commonly broken off and lost. The worm has been found in only one bird out of thirty-seven examined.

II. Nemathelmintha,

a. Nematoda, round worms.

*Heterakis perspicillum*:—Intestine. Meigs, Wayne and Pickaway counties. Det. Foster.

This worm is the largest of the round worms found in chickens. It measures from 1 to 2½ inches in length. It is white or yellowish white in color and is generally found in the fore part of the small intestine.

*Heterakis papillosa*:—Caeca. Pickaway and Wayne counties. Det. Ransom.

This worm is much smaller than Heterakis perspicillum, measuring from ¼ to½ inch in length and scarcely the size of a pin in diameter. It is normally found only in the caeca.

*Syngamus trachealis,* (Gape worm) :—Trachea and bronchi. Wayne county. Coll. Allen, Harrison county. See p. 46.

III. Arthropoda,

a. Insecta.

(1.) Mallophaga.

*Menopon biseriatum*:—Skin. Det. Osborn. Wayne Co. This louse, Osborn states, is very common on chickens in Ohio.

## SOME OF THE MORE IMPORTANT PARASITES

The parasites selected for discussion in this bulletin, and of which more information concerning distribution is desired, were taken from the various parasitic groups, and include representatives which attack horses, cattle, sheep, swine and chickens. They were chosen because of their economic importance. While the records are not complete enough to indicate a general distribution of all of them, yet where they do occur they are quite troublesome.

The scientific name of each of the parasites discussed is given, together with the common name, if there is any, as are the location of the parasite within the host, and name of the host. These parasites are:

Horse Bot Fly, *Gastrophilus intestinalis*:—Larvae in stomach, horse.

Ox Warble Fly, *Hypoderma lineata*:—Larvae subcutaneous, cattle. Causes small lumps or swellings on their backs.

Scab Mite, *Psoroptes equi var. ovis*:—Skin. Sheep. Causes scab or scabies in sheep.

Stomach Worm, *Haemonchus contortus*:—Fourth stomach. Cattle, sheep and goats.

Nodular Worm, *Oesophagostomum columbianum*:—Adults in large intestine, larvae encysted in the wall of the large and small intestines, forming nodules. Sheep and goats.

Lung Worm, *Metastrongylus apri*:—Trachea and bronchi. Swine.

Round Worm, *Ascaris suum*:—Small intestine. Has been found in stomach, oesophagus and biliary tract. Swine.

Chicken Gape Worm, *Syngamus trachealis*:—Trachea and bronchi, attached to the lining membrane, chicken. Causes the disease known as gapes.

### HORSE BOT FLY (*Gastrophilus intestinalis*)

Six different kinds of horse bot flies inhabit various parts of the world. In the United States there are probably four species,

*Gastrophilus intestinalis; Gastrophilus haemorrhoidalis; Gastrophilus nasalis* and *Gastrophilus pecorum.* Of these four species, *Gastrophilus intestinalis* is probably the most common and widely distributed. In Ohio it has been found either in the adult or larval form in five widely separated counties, Wayne, Fulton, Darke, Franklin and Meigs. (See map, p. 24.) Unauthentic reports indicate its occurrence in many other counties of the state.

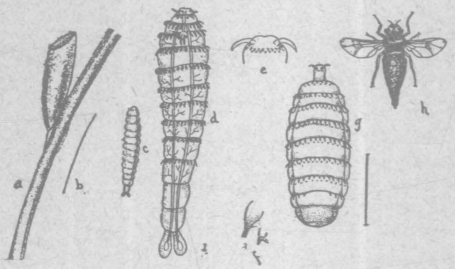


Fig. 2. The horse bot fly (*Gastrophilus intestinalis.*) a, egg attached to hair, enlarged about 15 times. c, young larva. d, same enlarged. e, oral hooks. f, body spines. g, full grown larva, about natural size. h, adult female, about two-thirds natural size. (After Osborn.)

The adult fly (Fig. 2) is about ¾ inch long. Each of its two transparent wings is marked by dark spots and a transverse band. The body is very hairy and of a brownish color.

The eggs are oval and light yellow in color.

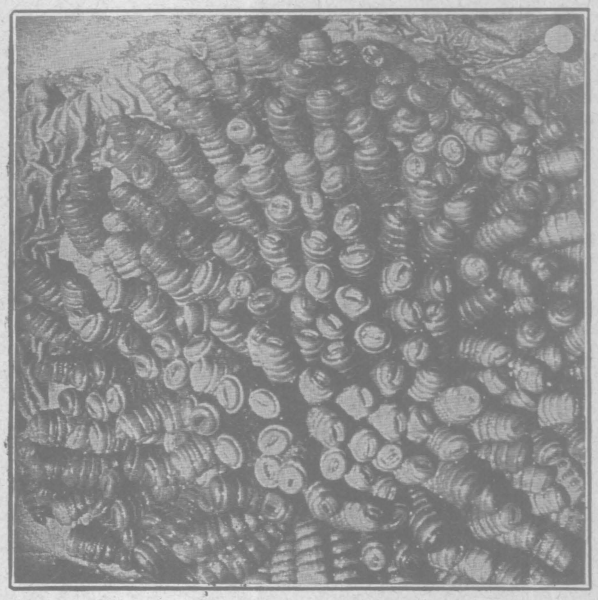


Fig. 3. Bots on the wall of a horse's stomach. (Osborn)

The newly hatched larvae are very small, slender and worm-like. Later they become larger, more nearly round and conical. They have at the head end two hooks directed backwards and two

rows of spines on the anterior portion of each of nine segments. On the free end of the last segment are located the two spiracles or breathing pores of the bot. The full grown bot measures from ¾ inch to 1 inch in length. (Fig. 2.)

During the summer and early fall months the female flies may be seen hovering around horses, waiting for an opportunity to deposit their eggs. The eggs are glued generally to the hairs of the shoulders, legs, and under side of the body, although some may be deposited upon the mane and hairs of other parts of the body. Moisture and friction seem necessary to hatch these eggs. When the horse licks itself or its companion, the cap of the egg is removed and the waiting larva is transferred by the tongue or lips to the mouth; from there it passes to the stomach, where it attaches itself by means of its two hooks. Here it takes nourishment and grows until the following spring when, reaching maturity, it loosens its hold and passes out with the droppings. It then burrows into the ground to pass the pupal stage. After 30 or 40 days the adult fly emerges, and is then ready to continue the reproduction of its kind.

Bots, when in sufficiently large numbers, (Fig. 3), interfere seriously with the process of digestion. If confined to the pyloric end of the stomach they interfere with the free passage of food from the stomach to the intestines. Their attachment causes irritation and injury to the walls of the stomach and interferes with glandular action. As they attach themselves to the rectum on their way out they may cause considerable irritation and inflammation in this region.

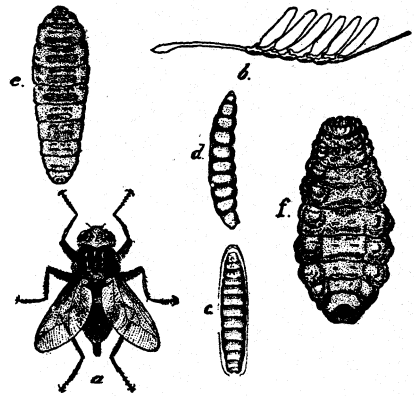



Fig. 4. Ox warble fly. a, adult fly. b, eggs attached to a hair, enlarged about 15 times. c, egg showing young larva just before hatching. d, larva from oesophagus. e, later stage found in back. f, mature larva, all slightly enlarged. (After Riley.)

**OX WARBLE FLY** (*Hypoderma lineata*)

The ox warble fly is about one-half inch long, black in color, and very hairy. The dorsal surface of the thorax is covered with yellowish gray and black hairs and marked by smooth, glistening black longitudinal bands. The abdomen is covered at its base with white or yellowish hairs, in the middle with black hairs, and at its extremity with red hairs. The mouth parts of the fly are rudimentary and not adapted to piercing, as are those of the mosquito,

nor can it sting the cattle, as it is sometimes reported to do. After mating of the male and female, the female deposits its eggs upon the hairs of cattle, particularly on the legs just above the hoofs. When the animal licks the hairs where these eggs are placed, the larvae hatched from them are carried by the tongue into the mouth.* The young maggots pass into the gullet and soon penetrate its walls. From the gullet they migrate through the tissues to the back, where they may be found under the hide during the late winter and early spring months. Small lumps or swellings on the backs of cattle indicate the position of the grubs. Each swelling or warble is perforated by a small hole through which the mature grub makes its exit and falls to the ground. Under rubbish, or in the ground, the grubs pass through the pupation stage, which lasts from 3 to 6 weeks. At the end of this time the adult fly emerges from the pupal case through a circular opening in one end.

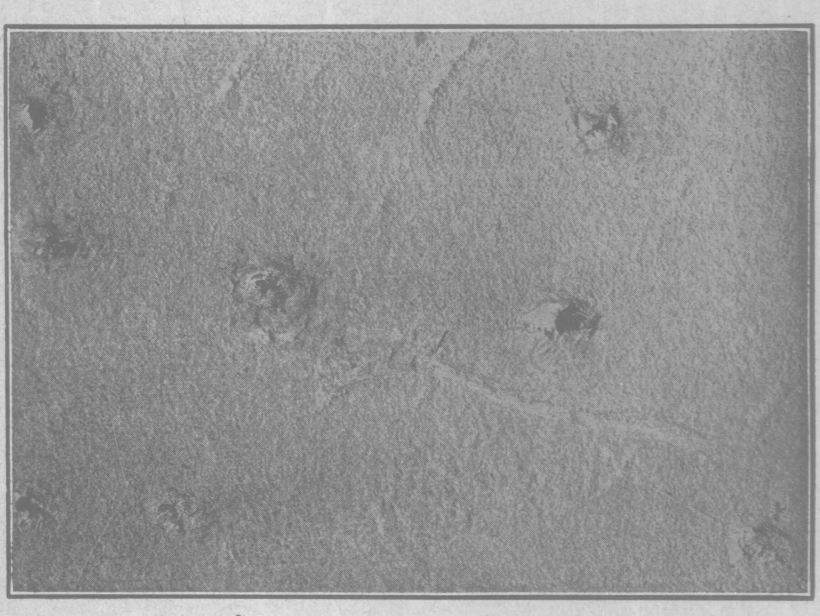


Fig. 5. Photograph of a piece of finished hide, showing effect of grubs on the leather.

The ox warble fly is one of the very harmful insect pests of live stock in Ohio. The grubs in the backs of cattle are a source of irritation, and the punctures which they produce seriously reduce the value of infested hides for leather products. It is said that the flesh around the wound is sometimes so changed, by the inflammation set up by the grubs, that it is unfit for sale and must be discarded. This causes substantial loss, especially as the more valuable cuts are most frequently affected.

*Recently the newly hatched larvae have been observed boring through the hide from the outside, throwing doubt on this commonly accepted statement of their path of entrance. (Jour. Dept. Agr. and Tech. Instruction for Ireland. Vol. 25. No. 1.)

The loss caused by the warble fly is not easily estimated, owing to the absence of reliable data. However, Miss Eleanor Ormerod, a British entomologist, as the result of many inquiries and testimony from numerous sources, estimated the damage to cattle in England at $5.00 per head; the loss from this insect for one period of six months (January to June, 1889) on the cattle coming into the Chicago Stock Yards, (1,335,026), was estimated at over $3,000,000, of which $600,000 represented actual loss on perforated hides, (Osborn, '96). Professor Herbert Osborn states that, omitting the creature's comfort as a matter of mere sentiment, and considering the question from the practical view-point of money returned, it requires only a very modest estimate of the loss at $1.00 per head on the cattle of the United States to show a loss of about $36,000,000 sustained by the country on the basis of the census of 1880. But now there are over 56,000,000 milk and other cattle in the United States, which, at $1.00 per head, would make the loss equal the enormous sum of $56,000,000. The Farmer's Review reported, as a result of an investigation conducted in 1889, that 50 percent of the cattle in Ohio were "grubby." On this basis, assuming the damage at $1.00 per head, Ohio stockmen and farmers are losing a little less than $1,000,000* annually from the ravages of the warble fly alone.

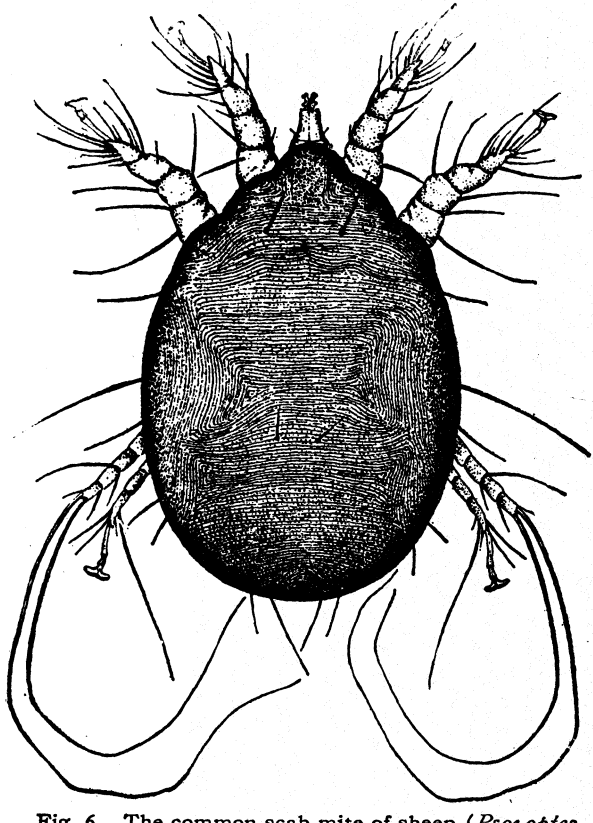


Fig. 6. The common scab mite of sheep (*Psoroptes equi var. ovis*) enlarged almost 100 times. (Bureau of Animal Industry, Bul. 21.)

*Based on the 1910 U. S. Census, 1,837,607 milk and other cattle in Ohio.

This fly possibly exists in every county of the state where cattle are raised, but it seems to be more abundant in some localities than in others. The conditions that are responsible for this difference are not fully known. For this reason it is highly desirable that more nearly complete records be made of its distribution and abundance.

### SCABIES IN SHEEP (*Psoroptes equi var. ovis*)

This highly contagious disease is caused by a small mite, *Psoroptes equi var. ovis* (Fig. 6) easily seen on a dark background with the naked eye, but not very easily found upon a scabby sheep.

**Fig. 7. A well developed case of sheep scab due to the common mite (*Psoroptes equi var. ovis*). From Bureau of Animal Industry, Cir. 19**

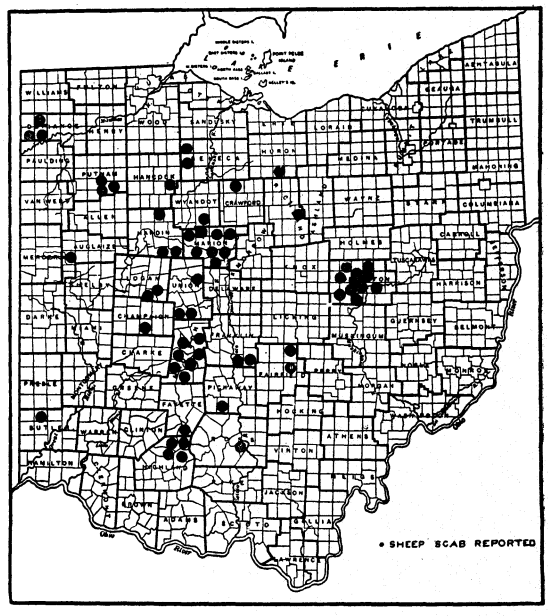
According to Salmon and Stiles (1903) the life history of the parasite is as follows:

"The female mite lays from 15 to 24 eggs on the skin, or fastened to the wool near the skin; six-legged larvae are hatched; these larvae shed their skin several times and become mature; the adult mites pair and the females lay their eggs, after which they die. These parasites increase very rapidly." Salmon and Stiles estimate that in three months' time, with 15 days as an average for each generation of 10 females and 5 males, the 6th generation would appear, and would consist of about 1,000,000 females and 500,000 males.

These mites lacerate the skin of sheep to obtain their food, and their wounds are followed by intense itching, irritation, formation

of small swellings, inflammation, exudation of serum, and the formation of crusts or scabs. As the parasites multiply they spread to the healthier tissue. In from two to three months the entire body may be affected. As the disease progresses the sheep become restless, scratch and bite themselves, and rub against posts, fences, or stones in order to relieve the itching. The wool becomes matted and is rubbed or pulled off by the sheep (Fig. 7). The skin becomes inflamed, scabby and thickened, furrowed, and bleeding in the cracks.

Sheep scab is exceedingly contagious. Healthy sheep may show infection within a week after being exposed to the disease. The mites causing the disease may spread by direct contact of one sheep with another, or by means of tags of wool, the scabs, bedding, etc.




Unless proper methods of treatment are adopted the disease will result in weakness, loss of flesh, exhaustion, and may result in a loss by death of from 10 to 80 percent of the flock.

Dr. Paul Fischer ('09) stated that "the loss from this disease to Ohio sheep raisers is at least $20,000. The disease is getting a stronger foothold in Ohio every year. The enforcemnt of good laws will stamp the disease out of existence." More recently, however, Dr. Fischer, in a letter to the writer, made the following statement: "Since January 1, 1913, eight hundred and sixty-five sheep were quarantined in Ohio on account of scabies. Seven hundred and fifty-eight have been reported infected, but have not yet been inspected. This shows the considerable decrease in numbers compared with previous years."

Quarantine regulations, established by the U. S. Government, and steps taken to eradicate the disease in the quarantined areas are doing much towards stamping out this trouble. Here is a

striking example of what can be accomplished in combating a parasite when its distribution is known and a systematic effort is made to eradicate it. It is expected that ultimately the parasite will be eradicated from the United States.

### THE SHEEP STOMACH WORM (*Haemonchus contortus*)

This parasite is commonly known as the sheep stomach worm. It has also been called the "wire worm" and the "striped worm." The first name indicates its location, i. e., the fourth stomach; the others refer to the appearance of the worm.

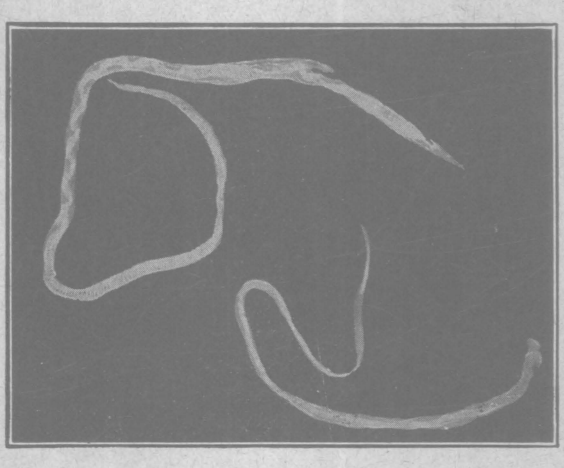


**Fig. 8. Sheep stomach worm (*Haemonchus contortus*) Male, smaller worm; female, larger worm, enlarged about 5 times.**

The male *Haemonchus contortus* (Fig. 8) measures about ¾ inch long when mature, and has at the posterior end a characteristic bi-lobed clasping organ. The female measures 1¼ inches and is easily recognized by a characteristic spiral striping. Both worms are red.

The following information relative to the life history is taken from Ransom (1906). The adult worms are found in greatest abundance in the fourth stomach. The female produces large numbers of eggs which pass out with the droppings. These eggs hatch in about two days, depending upon the temperature and moisture conditions. The very minute larva, after leaving the egg, begins to feed and grow. In from ten to fourteen days it reaches what is called the ensheathed stage, in which the former outer skin completely encases the larva. It is now prepared to wait for its host. Previous to this stage the eggs and the young larvae were easily killed by low temperatures and drought. The ensheathed larva is very resistant. It no longer feeds. During warm, wet weather, and while the dew is on the grass the ensheathed larva crawls up the blades of grass, and sheep and cattle grazing upon the grass take the waiting larva into the stomach where it develops into an adult worm. (Fig. 9.)

Sheep infested with stomach worms show indications of digestive disturbances and malnutrition. Their appetites become capricious, and the animal loses strength. Diarrhea often develops. If an animal is heavily infested, anemia, loss of flesh, and general weakness soon appear. The anemic condition is indicated by pallor around the mouth and eyes, and by the development of watery swellings under the lower jaw.

This worm has been the bane of Ohio sheep for many years. J. E. Wing ('98) states that it is "undoubtedly responsible for most of the deaths among lambs," and he has since made every effort to acquaint sheepmen with its importance.

This stomach worm no doubt occurs within the state wherever sheep are raised, but we have records of its occurrence in only a few of the sheep raising counties.

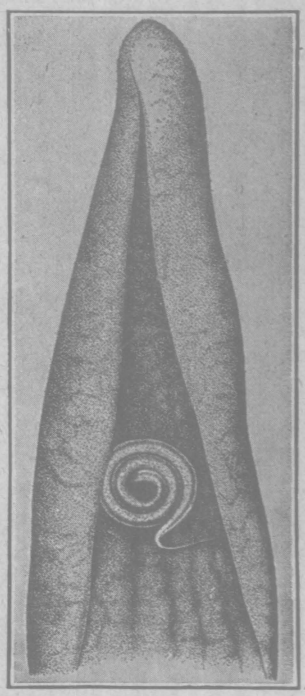


Fig. 9. Embryo of *Haemonchus contortus* coiled near tip of grass blade. Enlarged about 120 times. From Ransom.

### THE NODULAR WORM

(*Oesophagostomum columbianum*)

This worm in the adult stage is found in the large intestines of sheep. The embryos, or younger stages of the worm, are found in nodules (Fig. 11) mostly in the mucous lining of the intestines. For this reason the worm is commonly known as the nodular worm. The female attains a length of about 5-8 inch, the male is a little shorter (Fig. 10). The worms are solid white in color which distinguishes them from most other sheep parasites, some being partially translucent, yellowish, or red. This worm has been likened to a hook, since its head end is usually bent over.

The life history of this worm is only partially known. The eggs pass out with the droppings. What happens from this time until the embryos are found in the nodules is not fully known. The embryos are at first enclosed within a cyst in the nodules. Later they escape from the cyst and live in the cheesy matter in the nodule. Still later they escape from the nodules and attain maturity in the large intestines. Some investigators affirm that the nodule stage is not essential in the development of this worm; that the worm may reach maturity without penetrating the intestinal wall. Other

investigators believe that normally the tiny worms penetrate the intestinal wall, the nodules being formed only when they penetrate too deep, or when pathogenic bacteria are introduced.

Nodular disease of sheep probably existed in Ohio as early as 1873. In a paper published in the Ohio Agricultural Report of that year, Dr. N. S. Townshend, in discussing the pathological conditions of sheep affected with an ailment then known as "white skin," or "paper skin," mentions that "in some places the intestinal tube is much contracted or almost closed by the multitude of tubercular masses. These masses when divided are almost gray or greenish in color and of a cheesy constituence. Some of them are calcareous and cannot be cut with a knife." This corresponds rather closely to Curtice's (1890) report on the pathology of nodular disease, and, since sheep are rarely subject to tuberculosis, the

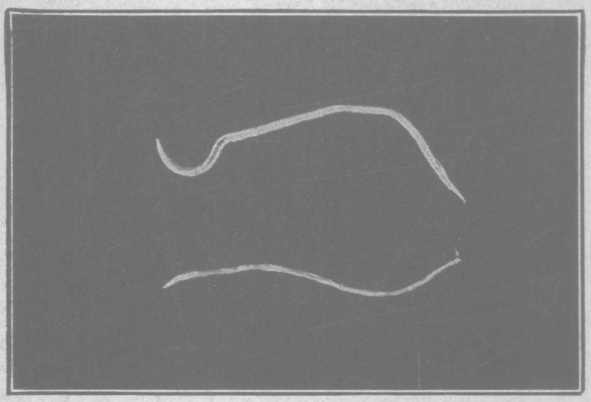


**Fig. 10.** The sheep nodular worm (*Oesophagostomum columbianum*). Male, lower worm; female; upper worm, enlarged about 3 times.

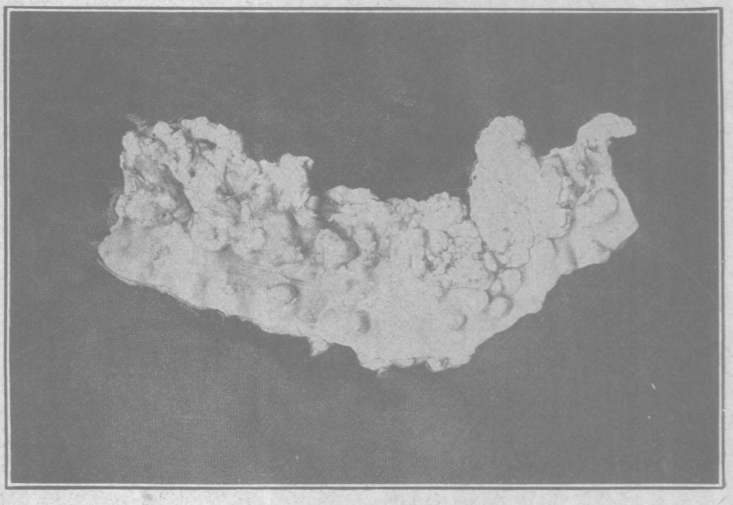
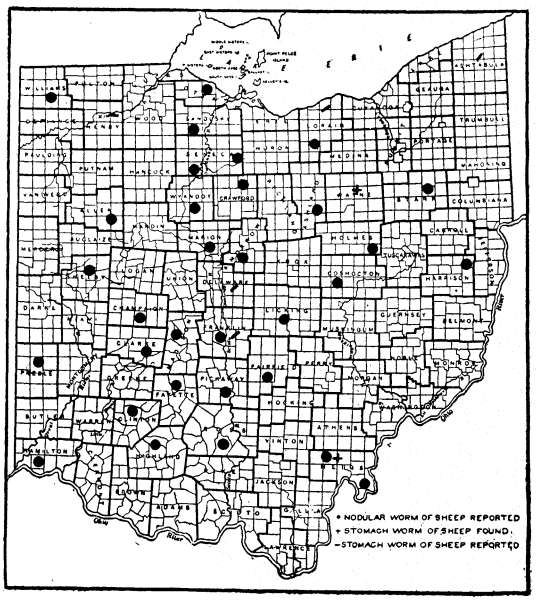


**Fig. 11.** Small portion of intestine of sheep, showing heavy infection with nodular worm (*Oe. columbianum.*)

condition described by Dr. Townshend was very likely due to *Oesophagostomum columbianum.*

The Live Stock Commissioners of Ohio, in their report for 1904, made their first mention of the disease, as follows: "The disease occurs only in a few localities in this state. In the past year one outbreak was observed near Lockbourne." The following year, 1905, they reported: "Not many years ago nodular disease in sheep was unknown in Ohio, it is now reported more frequently from year to year and is becoming very destructive to sheep in several sections of the state. The disease frequently terminates in death, and in other cases it permanently affects the general health of the animal. Once introduced on a farm, it is a difficult matter to exterminate it. Its treatment is very unsatisfactory. The best preventive is the observation of care in the purchase of new stock. Farms free from the disease should not be stocked with sheep from infected areas." Here is a practical example of the desirability of knowing the distribution of an animal parasite.




The Live Stock Commissioners in 1905 printed a map showing 7 counties infected. The report for the next year showed 13 counties infected, the next year 15, the next year 25, the next year 26, and their report, published in 1910, showed 29. In this report they say: "Twenty years ago this disease was unknown in Ohio. Today it is common in 29 counties and probably present to some extent in every county where sheep are raised. We know very little about effective remedies for the trouble. Once a pasture has been infected, sheep should be kept off for several years until the worm parasites die out. A few thousand dollars spent in the investigation of remedies for this trouble would be a paying investment for the state."

### THE LUNG WORM (*Metastrongylus apri*)

This parasite, often referred to as *Strongylus paradoxus*, is known as the lung worm of hogs. It occurs in the air passages of the lungs. The worms are round, delicate and thread-like, and of a white or very light brownish color. The males attain a length of ¾ inch to 1 inch; the females, 1 inch to 1½ inches. (Fig. 12).

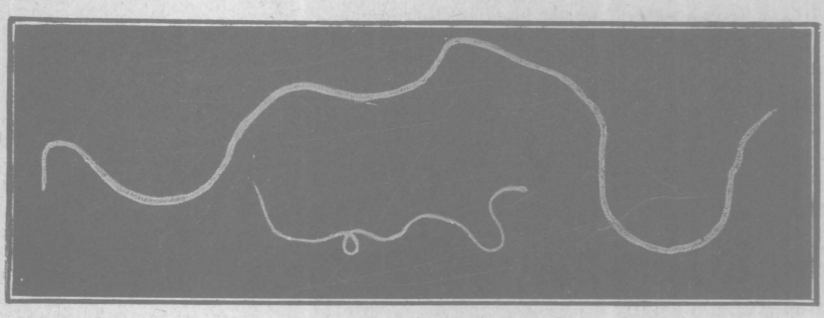


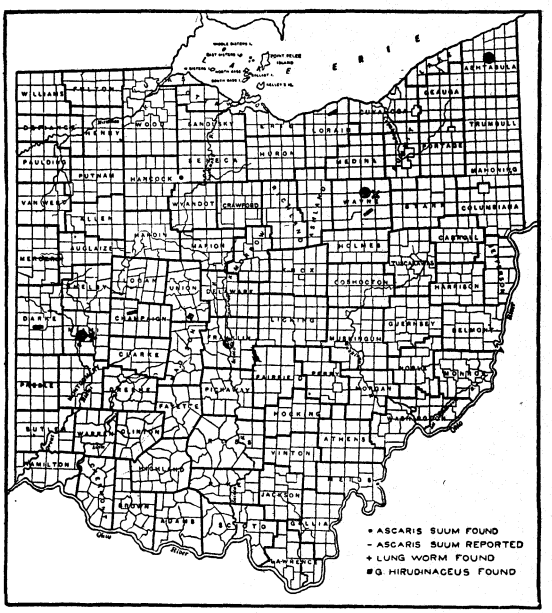
**Fig. 12. The lung worm (*Metastrongylus apri*) of hogs. Male, the shorter worm; female, the longer worm, enlarged about 6 times.**

The complete life history of this parasite is unknown. The adult male and female worms are found in the trachea and the bronchi of the lungs. There is, in infested animals, considerable mucus in these passages. An examination of this material under the microscope reveals numerous lung worm embryos, each enclosed within a shell. These embryos are probably carried to the outside during severe spasms of coughing when some of the phlegm is coughed up. From the time these embryos reach the exterior until they again find lodgment in the air passages of the lungs of another hog, very little is known concerning them. Some authorities think they have a simple life history and that hogs become infested through the contamination of their food and water. Others think that they have a more complicated life history, requiring the presence of an intermediate host in order to complete their development.

The presence of these worms in the air passages results in irritation of the mucous membranes, with an abundant secretion of slimy, viscid material which, together with the worms and verminous debris, may obstruct the lumen of the small air passage. The affected portion appears either dark red or grayish, and feels solid to the touch. Infestation is sometimes indicated by severe spasms of coughing. The pigs may have difficulty in breathing when driven. If the infestation is a heavy one the symptoms will be

aggravated; difficulty in breathing, coughing, and a general debility, associated with an emanciated condition, will appear. The cough may be deep and convulsive and continue for some time, leaving the animal in an exhausted condition. Death through exhaustion or suffocation may occur.

The distribution of this parasite throughout the state is less known than that of most of the others treated in this publication. It has been collected from only two counties, Wayne and Miami. However, the writer has heard the characteristic cough in several other counties. Still, coughing is not always caused by lung worms. Mechanical irritation and bacterial infection are also capable of causing a cough, so that the presence of this parasite in a herd cannot be definitely known except when the worms are found in the lungs or in material ejected from the lungs. More information about the prevalence of this parasite is desired.




THE ROUND WORM (*Ascaris suum*)

This parasite may properly be called the common intestinal worm of hogs, because of its frequent occurrence. The thorn-headed worm *Giganthorhynchus hirudinaceus* also inhabits the small intestine, but our records do not show it to be as common as the ascarid. The latter is easily distinguished from the thorn-headed worm. These two worms are the largest of the round worms found in the intestinal tract of hogs. The ascarid is bluntly pointed at each end, while the thorn-headed worm has a thorny proboscis at the head end. The ascarid is of a yellowish or brownish color; the thorn-headed worm is of a chalky white color. The

ascarid is found free in the small intestine, the thorn-headed worm is usually found attached to the walls of the intestine by means of its proboscis. The mature female ascarid attains a length of 10 to 14 inches and a diameter of ¼ inch; the male grows to a length of 5 to 7 inches and has the posterior end curved. The female thorn-headed worm attains a length of from 8 to 15 inches and sometimes a diameter of ⅓ inch. The male grows to the length of 3 to 4 inches, with a diameter of 1-8 to 1-5 inch.

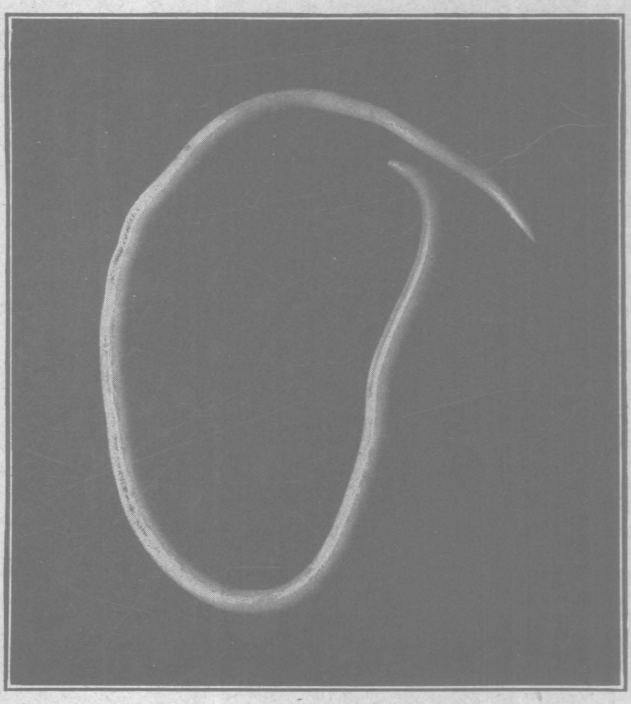


**Fig. 13.** The common intestinal worm of hogs (*Ascaris suum*). About natural size.

This parasite (the ascarid) has a direct life history. The adult female lives in the small intestine where it produces great numbers of eggs. These pass out of the intestines with the droppings and are scattered over the floors of the pens or over the pasture fields. The eggs are microscopic in size and possess very thick, rough shells. They are very resistant to drought and weathering. Under suitable conditions of moisture and temperature, development will take place within the thick shell. The eggs containing the developing embryos, or the embryos themselves, may be taken

into the intestinal tract in contaminated food and water. The shells may then be acted upon by the digestive juices and the embryos liberated. In the small intestine they feed upon the partially digested food, grow and mature. When mature, the male and female mate, and egg laying begins.

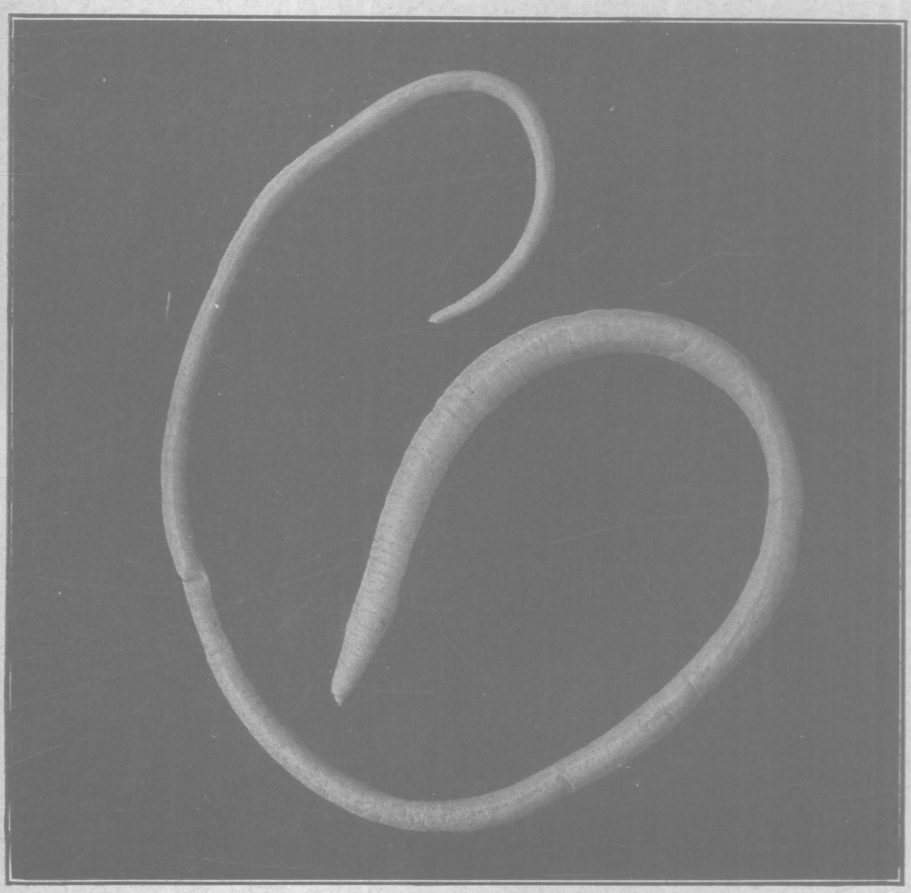


Fig. 14. The thorn-headed worm *Giganthorhynchus hirudinaceus*) reduced one-fifth

In small numbers these worms do but little damage. In pigs that are kept continually on the same ground, or that drink water which has drained from other pig pens or yards, the worms often appear in great enough numbers to do much injury. Such heavy infestations may cause severe disturbances of the digestive system. Cases have occurred in which several hundred worms have been found in the intestines of one hog. The writer has collected as many as 162 ascarids from one pig. They live chiefly in the small

intestine, but sometimes enter the stomach. In some instances they have been recorded as perforating the walls of the intestine and entering the abdominal cavity. They have also been found in the gall duct and gall bladder. In the pig referred to above the worms were found in the mouth, trachea, oesophagus, stomach, bile duct, gall bladder, hepatic ducts, and the small intestine. The pig died, probably as a result of this heavy infestation of worms.

Fig. 15. Portion of hog's intestine with thorn-headed worms attached. The worms are shrunken and immature.

Ascarids may be found throughout the entire year, their abundance depending upon sanitary as well as seasonal conditions. The prevalence and distribution of this parasite are not so very well known. This Station has collected the parasite wherever looked for, not from every animal, but in every locality. Letters and reports of its occurrence have come from many sources. More definite information is desired.

### THE GAPE WORM
(*Syngamus trachealis*)

This parasite, a round worm, lives in the windpipe and sometimes causing a disease known as gapes. It is among young chickens that the gape-worm does in the bronchial tubes of chickens,

the most damage in Ohio, but it may also infest turkeys, pheasants, partridges, sparrows, linnets, starlings, rooks, martins, swifts and green woodpeckers.*

The body of the gape-worm is cylindrical and of a red color. The adult male worm is found attached to the female, so that the two present a forked appearance. The smaller branch of the fork is the male, and it measures when mature about 1/5 inch in length. The adult female measures about 4/5 inch in length. The eggs are oval and very small, measuring scarcely 1-250 inch in diameter. They are not laid, but when the female becomes mature and filled with eggs, they, together with the attached male, are coughed up by the bird. The other chickens often immediately swallow these worms, and the eggs are thus liberated. Or the eggs may be liberated by the bursting or decomposition of the body of the female. In this manner the poultry runs are infested.

Fig. 16. Gape worm of chickens (*Syngamus trachealis*). Small worm (left prong), male; large worm, female. (After Neveu Lamaire, enlarged about 3 times.)

These eggs hatch into tiny white worms in from 7 to 40 days, depending upon the moisture and temperature. Experiments have shown that birds fed gape-worm eggs and embryos will develop gapes. Hence their development is direct, no secondary host being necessary. However, it has been observed that the eggs and embryos remain alive in the digestive tract of the earth worm, and birds swallowing these worms may become affected with gapes. The earth worm thus acts as a carrier of the disease rather than as a necessary secondary host. It is also quite probable that wild birds play some part in the dissemination of this parasite.

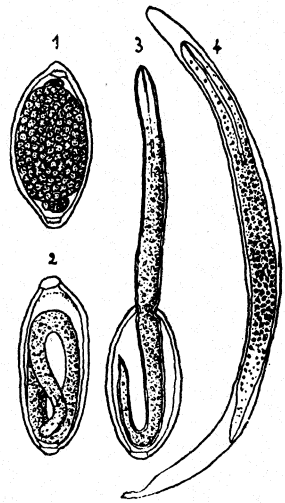



Fig. 17. Life stages of the gape worm. 1, egg; 2, egg containing an embryo; 3, hatching; 4, larva. (After Railliet, enlarged about 200 times.)

Gape-worm disease is caused by the worms attaching themselves by their mouths to the walls of the air passages, sucking

*Leaflet 58, Board of Agriculture and Fisheries, England.

blood, and injuring the lining membrane. They may, if present in sufficient numbers, stop up the wind pipe and thus cause death by suffocation. Young chicks are more susceptible, although old chickens are sometimes attacked.

Gapes was reported for the first time in 1799, by Wiesenthal, who observed it at Baltimore, Maryland, in chickens and turkeys. It has since been observed many times in various parts of the United States, in England, France and Germany. In Ohio it has been reported as causing considerable losses among the young chickens in various parts of the state. The Experiment Station has reports of its ravages among flocks in three counties, Summit, Wayne and Harrison. Specimens of the gape-worm have been received from Wayne and Harrison counties.

## COMBATING ANIMAL PARASITES

Although the life history of many of the parasites is not known, yet sufficient knowledge is at hand concerning the way in which parasites are spread to indicate that upon the proper care of livestock and their surroundings depends, in a great measure, the prevention or control of parasitic diseases. The eggs of the stomach and intestinal worms pass out with the droppings and are scattered over the pens, feed lots and pastures. The larval stage of many of these parasites, after a period of growth, may, if picked up by the proper host animal, complete its development in the stomach or intestines. The little mite which causes sheep scab may be transmitted from a diseased sheep to a healthy one by direct contact or by means of the feed racks, partitions and other things against which the sheep rub. It is thus apparent that the above mentioned parasites may be controlled to a certain extent, by observing the simple precautionary measures of cleanliness, and periodic disinfecting with such materials as lye water, hot lime wash or some other reliable disinfectant.

Many of the parasites may be transmitted to the animals by means of the drinking water. Every precaution should therefore be taken to supply pure water. Great care should be exercised in handling the manure so that liquid from the manure may not find its way into the source of the water supply. The bogs and swamps in the pastures should either be fenced off or tile drained, as the water in these places sometimes contains the larval forms of many of the parasites that are very injurious to live stock. The watering trough should be kept clean and free from animal excrement.

Pasturing and care of the pastures are very important items in the control of parasites. If internal parasites of these animals prevail in troublesome numbers, it is of doubtful advisability to top

dress pastures with sheep or cattle manure from infested animals when the pastures are to be used for grazing these animals, as such a procedure may scatter immense numbers of eggs over the pastures and thus increase the chances of infection. The long continued pasturing of one class of animals upon the same pasture may also heavily infest the pasture. Similar results may follow when the pastures are overstocked. A rotation of pastures, rather than a long continued use of the same pasture, supplementing the permanent pasture with green forage crops, will greatly facilitate the control of parasites. However, this is not always practicable.

The practice of pasturing young animals with old ones is dangerous, if the older animals are infested with parasites, for young animals succumb more readily to the attacks of parasites than do the older ones.

In combating animal parasites attention should also be directed to the amount and kind of food supplied the stock. Many losses, supposedly due to animal parasites alone, are in reality due to partial starvation and the attacks of parasites combined. A partially starved animal is not as able to withstand the attacks of the parasites, nor can it replace the tissues consumed or destroyed as readily as can a well fed animal. Hence, many of the losses that would otherwise occur may be prevented by an adequate ration.

The carcasses of all animals dying on the farm should be disposed of by burning, or by deep burial, or by other sanitary methods, and a strong disinfectant should be scattered over the surface of the ground with which the dead animal has come in contact. If the carcass be allowed to lie for a long time, infection may be spread to the other animals, either by coming in contact with the dead body, or by dogs or birds which may feed upon the carcass. The dead body may contain immature forms of one or more of the animal parasites which reach the adult stage in the dog's intestines. The infested dog may then scatter the eggs of these parasites broadcast over the fields and elsewhere to be picked up by the live stock.

Medicinal treatment for parasites must be adapted to the individual parasite and the host animal affected. The various species of parasites inhabiting the same host animal cannot be eradicated by the same medicinal treatment. It is even somewhat improbable that the various species of intestinal parasites of one host animal can be removed by the use of the same medicine. For example, experiments at the Ohio Experiment Station indicate that copper sulphate has some value as a vermicide against the stomach worm

(*H. contortus*) and tape worm (*M. planissima*) of sheep, but that it is not effective against the whipworm (*T. ovis*) or nodular worm (*Oe. columbianum*). The cure-alls and panaceas are of little value in the treatment of parasitic diseases of livestock.

The medicinal treatment for some internal parasites is still in the experimental stage. No practical specific remedies are as yet known for the treatment of the lung worms of the various classes of livestock. Additional work is needed regarding the treatment of parasites in the alimentary tract. The value of the medicinal treatment with animals of small worth lies in the successful treatment of large numbers at one time. The treatment of the parasites of the liver and other organs of the body and of the muscles is probably the least productive of good results. Ransom ('12) sums up the work done in the latter field as follows: "The present state of our knowledge does not warrant any conclusion other than this, that a great amount of additional work is necessary and desirable."

On the other hand, the treatment of most of the external parasites is productive of good results. The more permanent external parasites, such as the scab mites, ticks and lice, may be effectively combated by dipping the infested animal in a properly prepared dip.

The ox warble fly may be kept in check by squeezing out the grubs and destroying them, thus preventing the completion of their life history. The removal from the hairs of the legs and other parts of the horse's body, and destruction of the eggs of the horse bot fly, will prevent the larvae from finding their way into the alimentary tract, which is necessary in order to complete their life history. This measure, if practicable, will greatly reduce the infestation and effect of this parasite.

Various remedies are recommended for removing the intestinal parasites. The following have been used, although not originated, by the Ohio Experiment Station with some degree of success:

For ascarids in hogs:—(1.) Omit one feed. (2.) In the next feed (one-half usual amount) give a dose of epsom salts (a tablespoonful to 100 pounds of liveweight). (3.) In the next feed (one-half usual amount) give 5 grains of santonin per 100 pounds of liveweight. (4.) Repeat No. 3 in the next one-half feed, and in the next feed give another dose of salts.

For sheep stomach worms and tape worms:—Keep the sheep away from food and water 18 to 24 hours before treating.

Dissolve 1 ounce of copper sulphate (bluestone) in 2 quarts of water and give to each individual a dose as follows:

For a lamb 3 months old give ⅔ of a fluid ounce (20 c.c.)
For a lamb 6 months old give 1⅓ fluid ounce (40 c.c.)
For a yearling give 2 fluid ounces (60 c.c.)
For a sheep 2 years old give 3 fluid ounces (90 c.c.)

Do not allow the sheep to have access to water for several hours after dosing. Should any of the sheep receive an overdose, indicated by lying apart from the rest of the flock, purging, and showing symptoms of pain, it is recommended that they be placed in a shady spot and given a teaspoonful of laudanum in a tumblerfull of milk. Use copper sulphate of a uniform blue color, without any whitish crusts or conglomerate lumps. Do not guess at weights and measures. Have your druggist weigh the bluestone and have him graduate your drenching bottle.

The bluestone (copper sulphate) treatment was first used by the Government Veterinarians in South Africa. Later it was introduced into the United States by the Bureau of Animal Industry, U. S. Department of Agriculture. It is believed that this treatment is less injurious to sheep and may be more speedily given than the gasoline treatment previously advocated by Mr. Hickman in Bulletin 117 of the Ohio Experiment Station.

## MORE INFORMATION NEEDED

It is very apparent that more nearly complete records of distribution are necessary, not only of the parasites discussed in this bulletin, but of the many others which are found in the state. The Ohio Experiment Station will greatly appreciate the cooperation of all in helping to complete these records. Specimens of parasites preserved in 70% alcohol may be sent to the Station for identification, and will be preserved here for future reference, the collector being given due credit.

## ACKNOWLEDGMENTS

Th appended bibliography has been drawn on quite freely in the preparation of this publication. The records herein published would have been even less extensive had it not been for the assistance of Dr. Fischer and the publications of the State Board of Live Stock Commissioners. The maps showing the distribution of sheep scab and nodular disease have been taken bodily from their 1908 report, only a few additional records having been made. The writer wishes to thank Professors Osborn and Hine, of Ohio State University, and Professor Gossard, of the Experiment Station, for their helpful suggestions.

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